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Gonsalves

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(54) **APPLICATION DISCOVERY AND INTEGRATION USING SEMANTIC METAMODELS**

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(51) **Int. Cl.**

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H04L 29/08	(2006.01)
H04W 4/00	(2009.01)

(52) **U.S. Cl.**

CPC .. ***G06F 8/70*** (2013.01); ***G06F 8/36*** (2013.01); ***H04L 67/16*** (2013.01); ***H04W 4/001*** (2013.01); *G06F 8/10* (2013.01)

(58) **Field of Classification Search**

USPC 717/120
See application file for complete search history.

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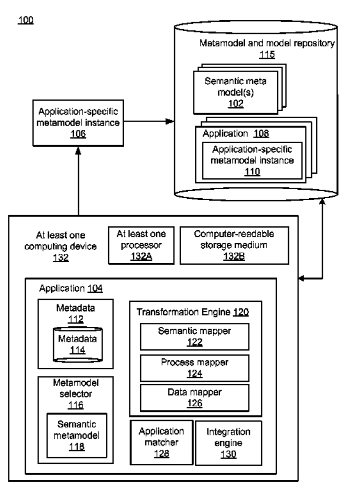
(57) **ABSTRACT**

A metamodel selector may determine a semantic metamodel for at least two software applications, the semantic metamodel including a description of semantics, processes, and data that are applicable to the at least two software applications. A metadata manager may determine application metadata describing an application of the at least two applications. A transformation engine may transform the application metadata into an application-specific metamodel instance of the semantic metamodel, and an integration engine may integrate the at least two software applications, based on the application-specific metamodel instance.

17 Claims, 11 Drawing Sheets



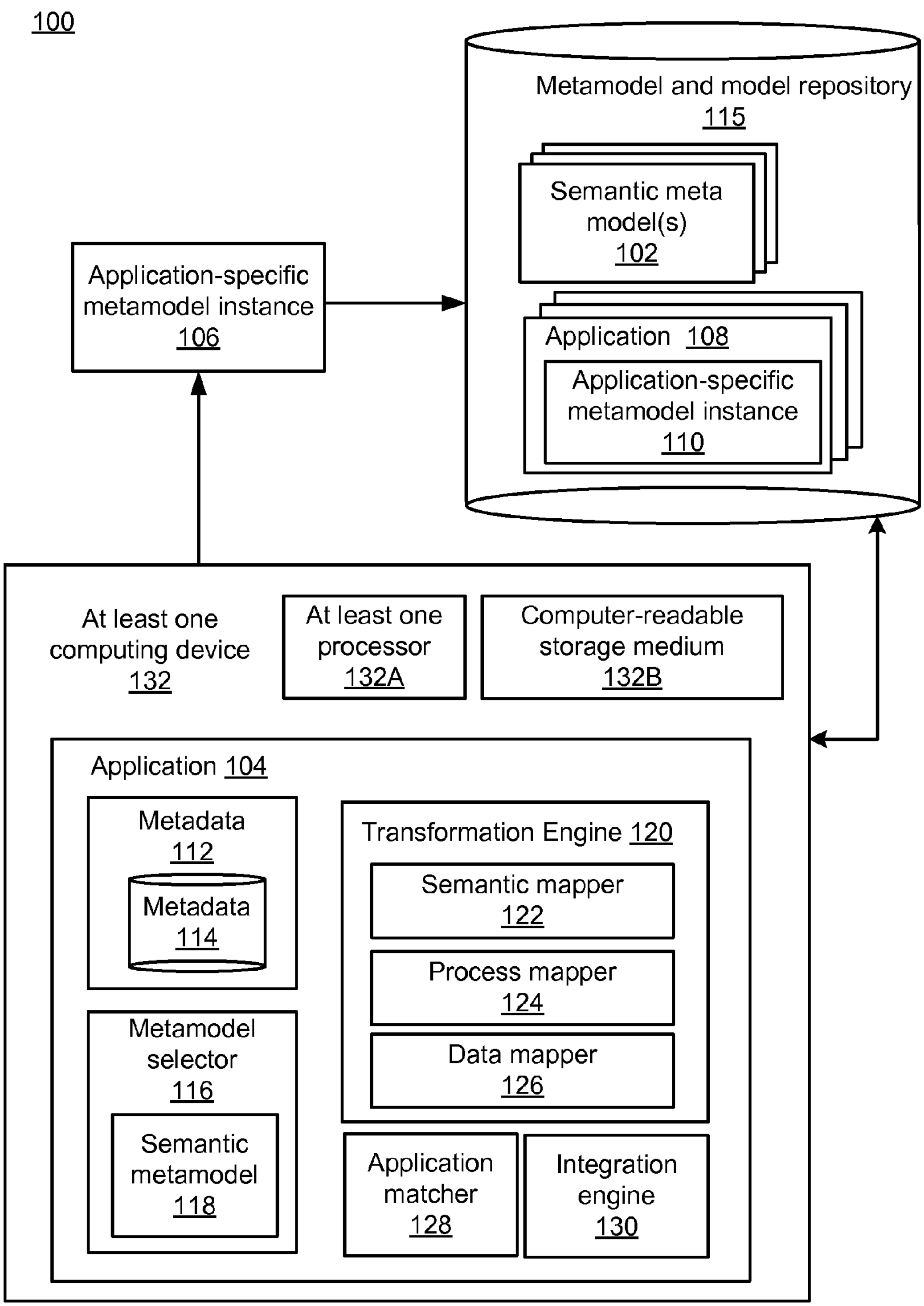

100
Metamodel and model repository
115
Semantic meta model(s)
102
Application-specific metamodel instance
106
Application 108
Application-specific metamodel instance
110
At least one computing device
132
At least one processor
132A
Computer-readable storage medium
132B
Application 104
Metadata
112
Metadata
114
Transformation Engine 120
Semantic mapper
122
Process mapper
124
Data mapper
126
Metamodel selector
116
Semantic metamodel
118
Application matcher
128
Integration engine
130

FIG. 1

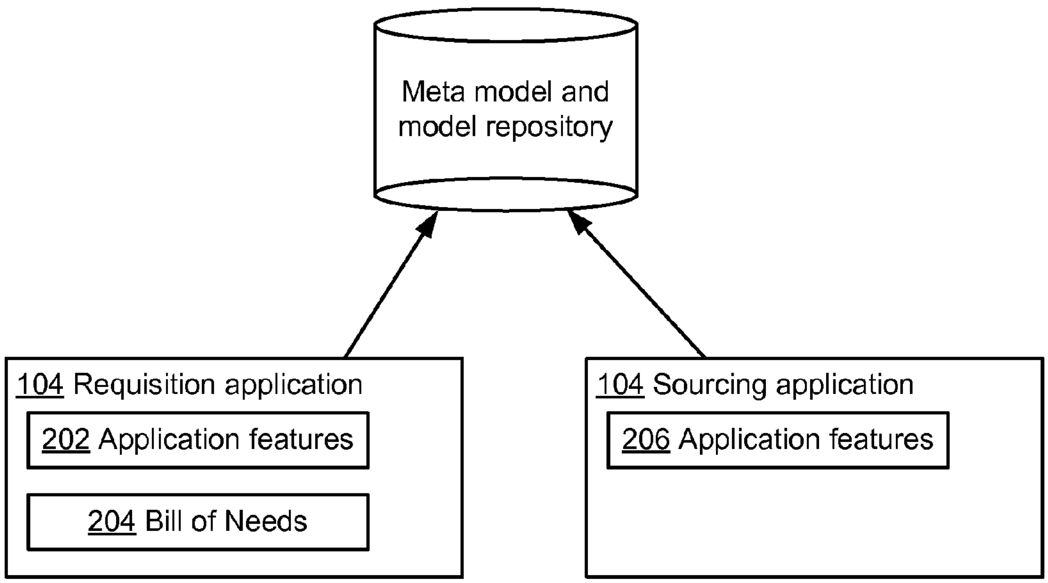

Meta model and model repository
104 Requisition application
202 Application features
204 Bill of Needs
104 Sourcing application
206 Application features

FIG. 2A

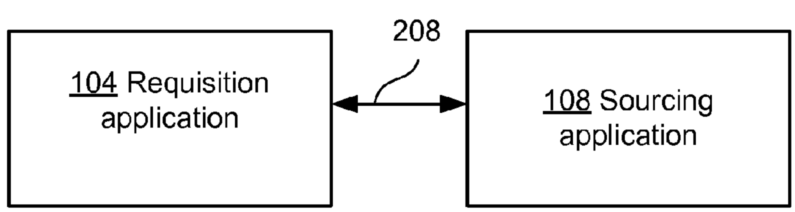

208
104 Requisition application
108 Sourcing application

FIG. 2B

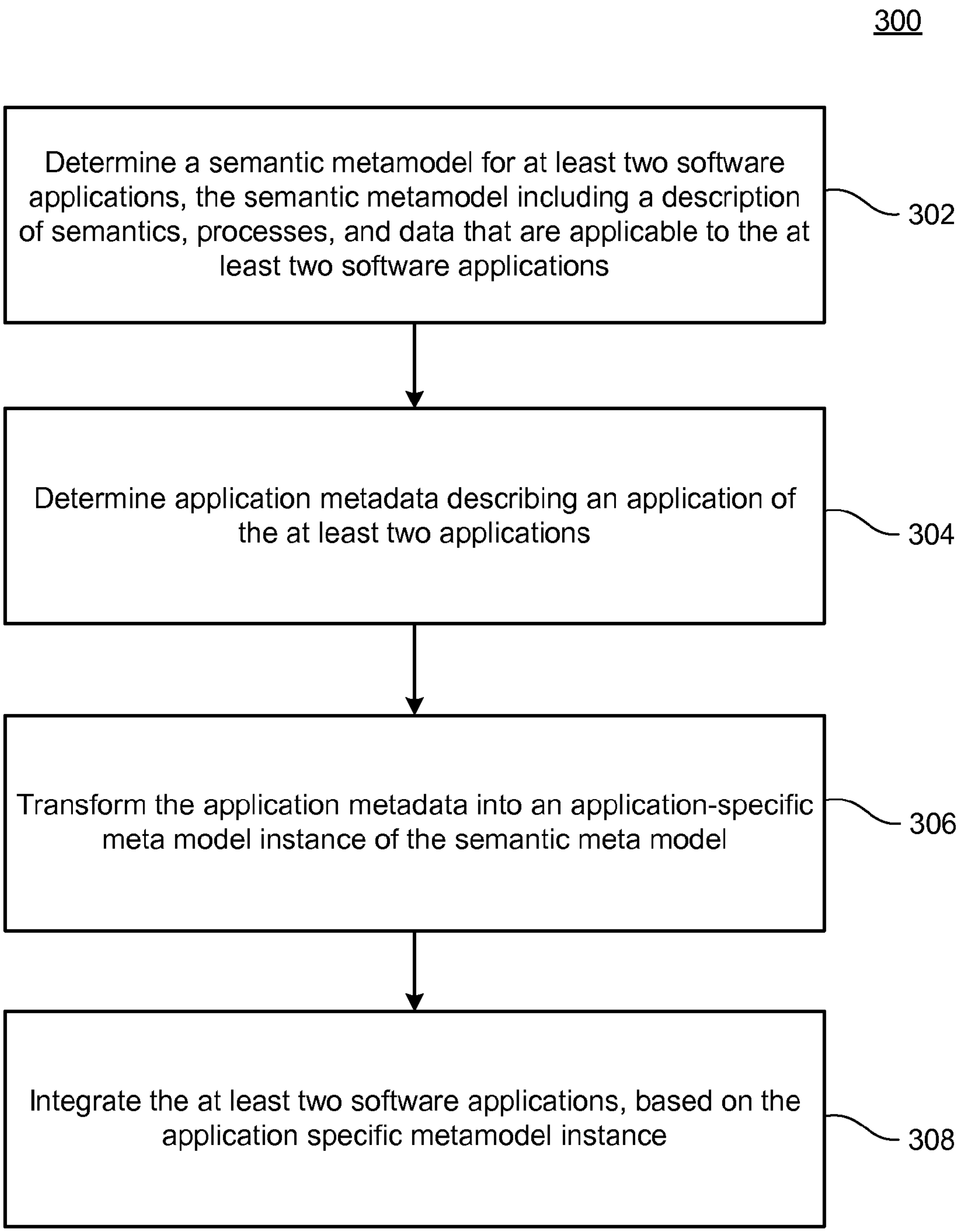

300
Determine a semantic metamodel for at least two software applications, the semantic metamodel including a description of semantics, processes, and data that are applicable to the at least two software applications
302
Determine application metadata describing an application of the at least two applications
304
Transform the application metadata into an application-specific meta model instance of the semantic meta model
306
Integrate the at least two software applications, based on the application specific metamodel instance
308

FIG. 3

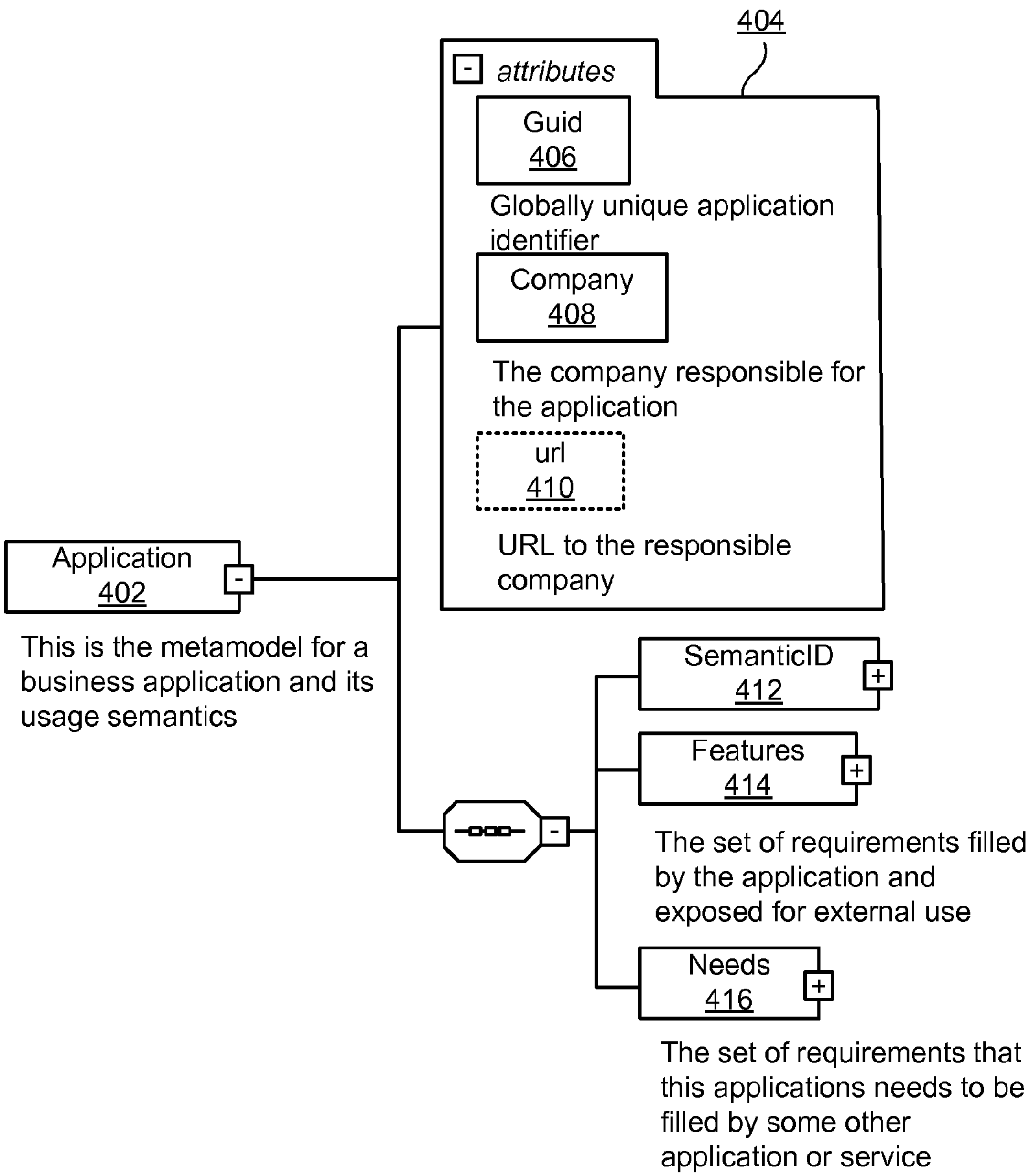

404
attributes
Guid
406
Globally unique application identifier
Company
408
The company responsible for the application
url
410
URL to the responsible company
Application
402
This is the metamodel for a business application and its usage semantics
SemanticID
412
Features
414
The set of requirements filled by the application and exposed for external use
Needs
416
The set of requirements that this applications needs to be filled by some other application or service

FIG. 4

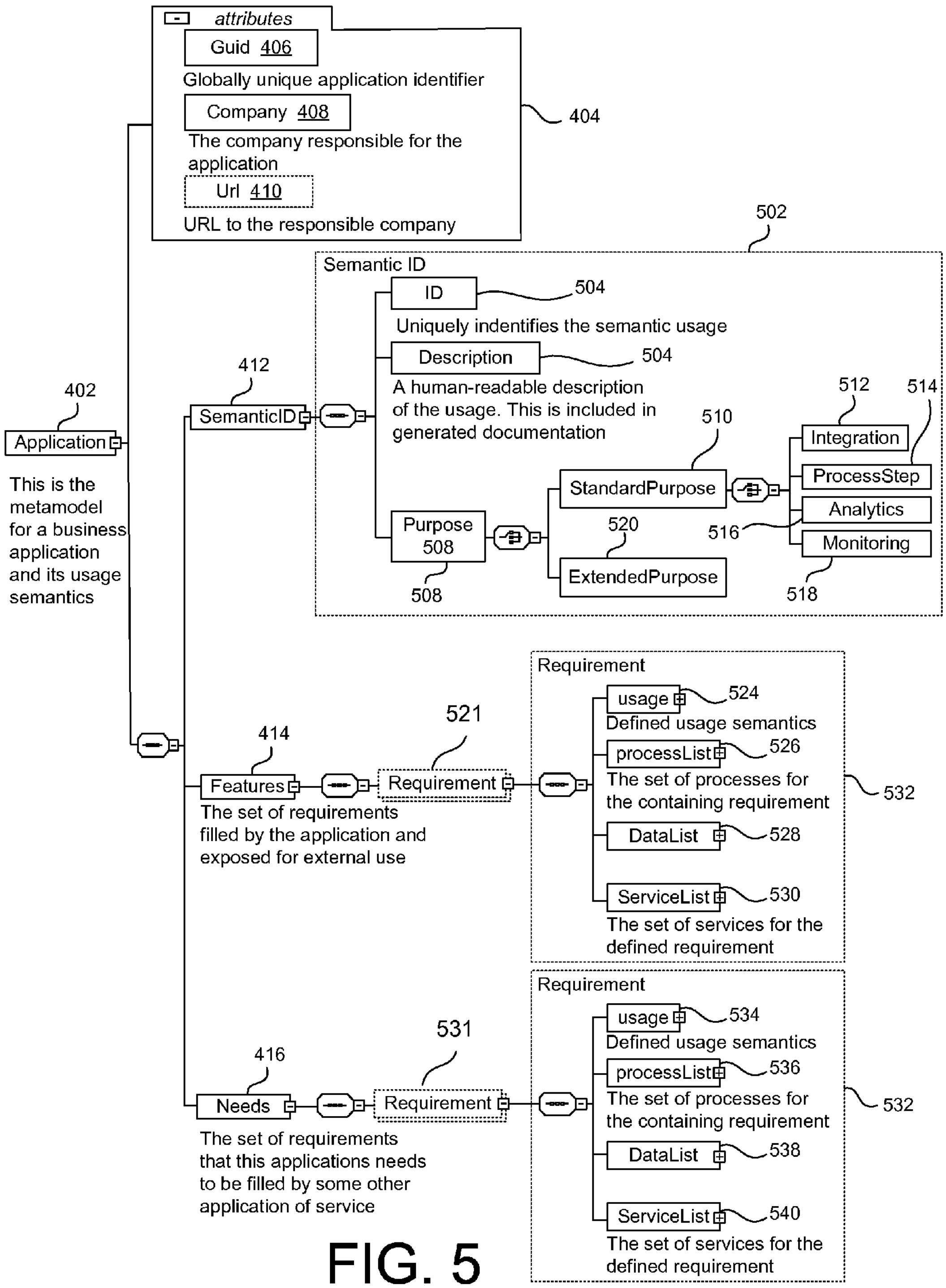
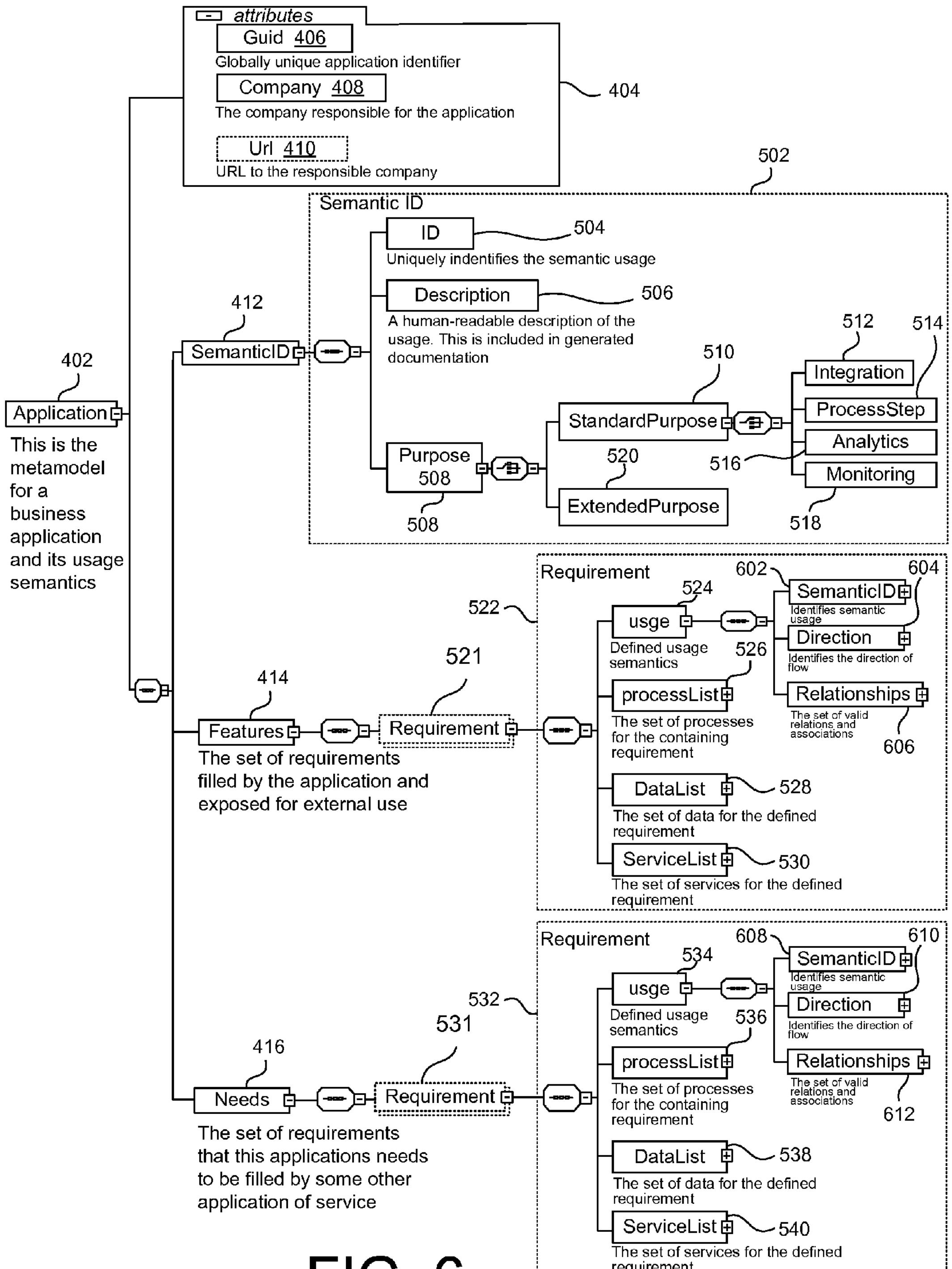
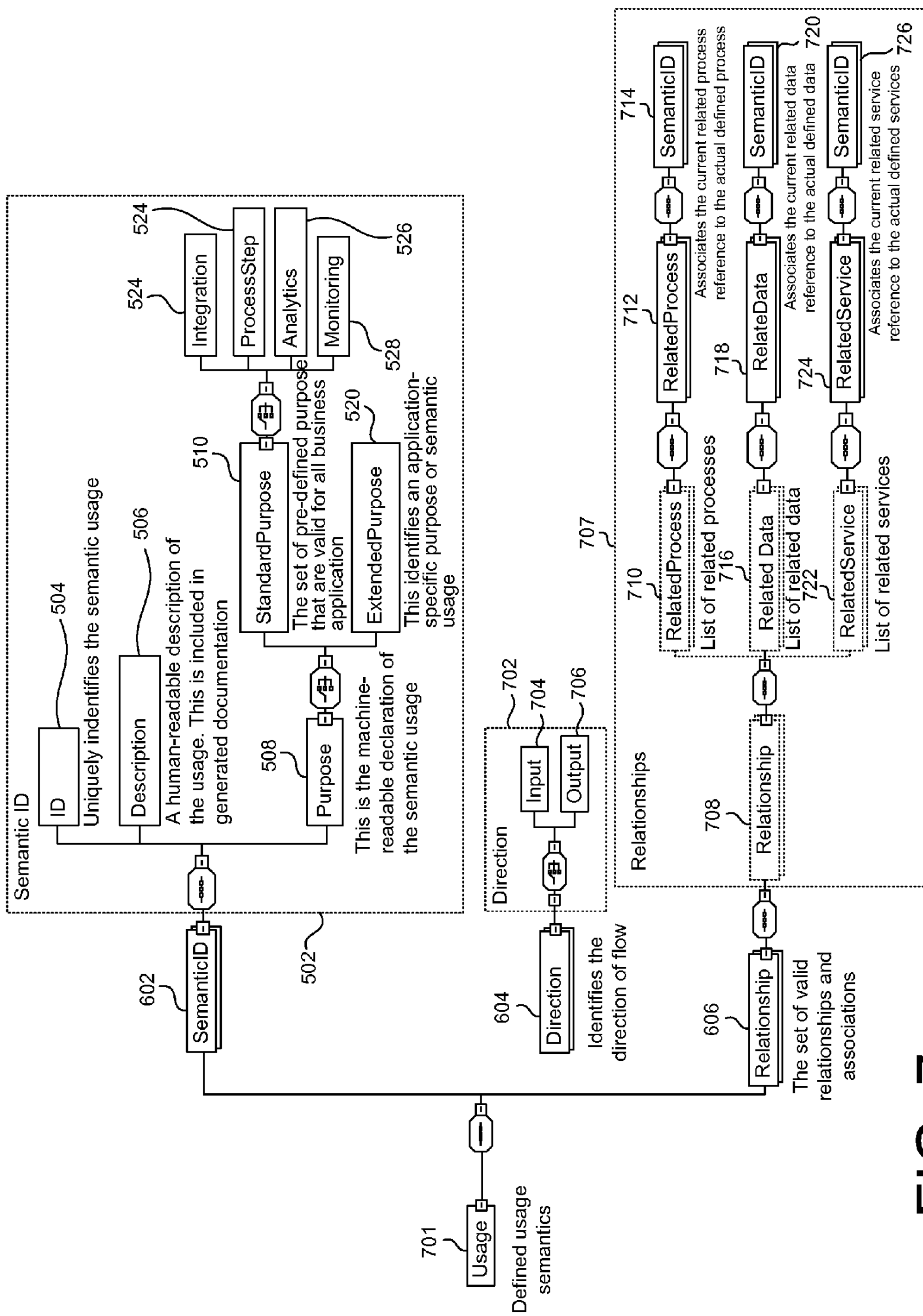

attributes
Guid 406
Globally unique application identifier
Company 408
The company responsible for the application
Url 410
URL to the responsible company
404
502
Semantic ID
ID
504
Uniquely indentifies the semantic usage
Description
504
A human-readable description of the usage. This is included in generated documentation
412
402
SemanticID
Application
This is the metamodel for a business application and its usage semantics
512
514
510
Integration
StandardPurpose
ProcessStep
Analytics
516
Monitoring
Purpose 508
520
ExtendedPurpose
508
518
Requirement
usage
524
Defined usage semantics
processList
526
The set of processes for the containing requirement
521
414
Features
Requirement
532
The set of requirements filled by the application and exposed for external use
DataList
528
ServiceList
530
The set of services for the defined requirement
Requirement
usage
534
Defined usage semantics
531
processList
536
416
The set of processes for the containing requirement
Needs
Requirement
532
The set of requirements that this applications needs to be filled by some other application of service
DataList
538
ServiceList
540
The set of services for the defined requirement

FIG. 5



attributes
Guid 406
Globally unique application identifier
Company 408
The company responsible for the application
Url 410
URL to the responsible company
404
502
Semantic ID
ID
504
Uniquely indentifies the semantic usage
Description
506
A human-readable description of the usage. This is included in generated documentation
412
SemanticID
402
Application
This is the metamodel for a business application and its usage semantics
510
512
514
Integration
ProcessStep
Analytics
Monitoring
StandardPurpose
Purpose 508
520
516
ExtendedPurpose
508
518
Requirement
602
604
524
SemanticID
Identifies semantic usage
522
usge
Direction
Defined usage semantics
526
Identifies the direction of flow
414
521
processList
Relationships
Features
Requirement
The set of valid relations and associations
The set of processes for the containing requirement
606
The set of requirements filled by the application and exposed for external use
DataList
528
The set of data for the defined requirement
ServiceList
530
The set of services for the defined requirement
Requirement
608
610
534
SemanticID
Identifies semantic usage
532
usge
Direction
Defined usage semantics
536
Identifies the direction of flow
531
416
processList
Relationships
The set of valid relations and associations
Needs
Requirement
The set of processes for the containing requirement
612
The set of requirements that this applications needs to be filled by some other application of service
DataList
538
The set of data for the defined requirement
ServiceList
540
The set of services for the defined requirement

FIG. 6



Usage
701
Defined usage semantics
SemanticID
602
502
Semantic ID
ID
504
Uniquely indentifies the semantic usage
Description
506
A human-readable description of the usage. This is included in generated documentation
Purpose
508
This is the machine-readable declaration of the semantic usage
StandardPurpose
510
The set of pre-defined purpose that are valid for all business application
ExtendedPurpose
520
This identifies an application-specific purpose or semantic usage
Integration
524
ProcessStep
524
Analytics
526
Monitoring
528
Direction
604
Identifies the direction of flow
Direction
702
Input
704
Output
706
Relationship
606
The set of valid relationships and associations
Relationships
707
Relationship
708
RelatedProcess
710
List of related processes
RelatedProcess
712
Associates the current related process reference to the actual defined process
SemanticID
714
Related Data
716
List of related data
RelateData
718
Associates the current related data reference to the actual defined data
SemanticID
720
RelatedService
722
List of related services
RelatedService
724
Associates the current related service reference to the actual defined services
SemanticID
726

FIG. 7

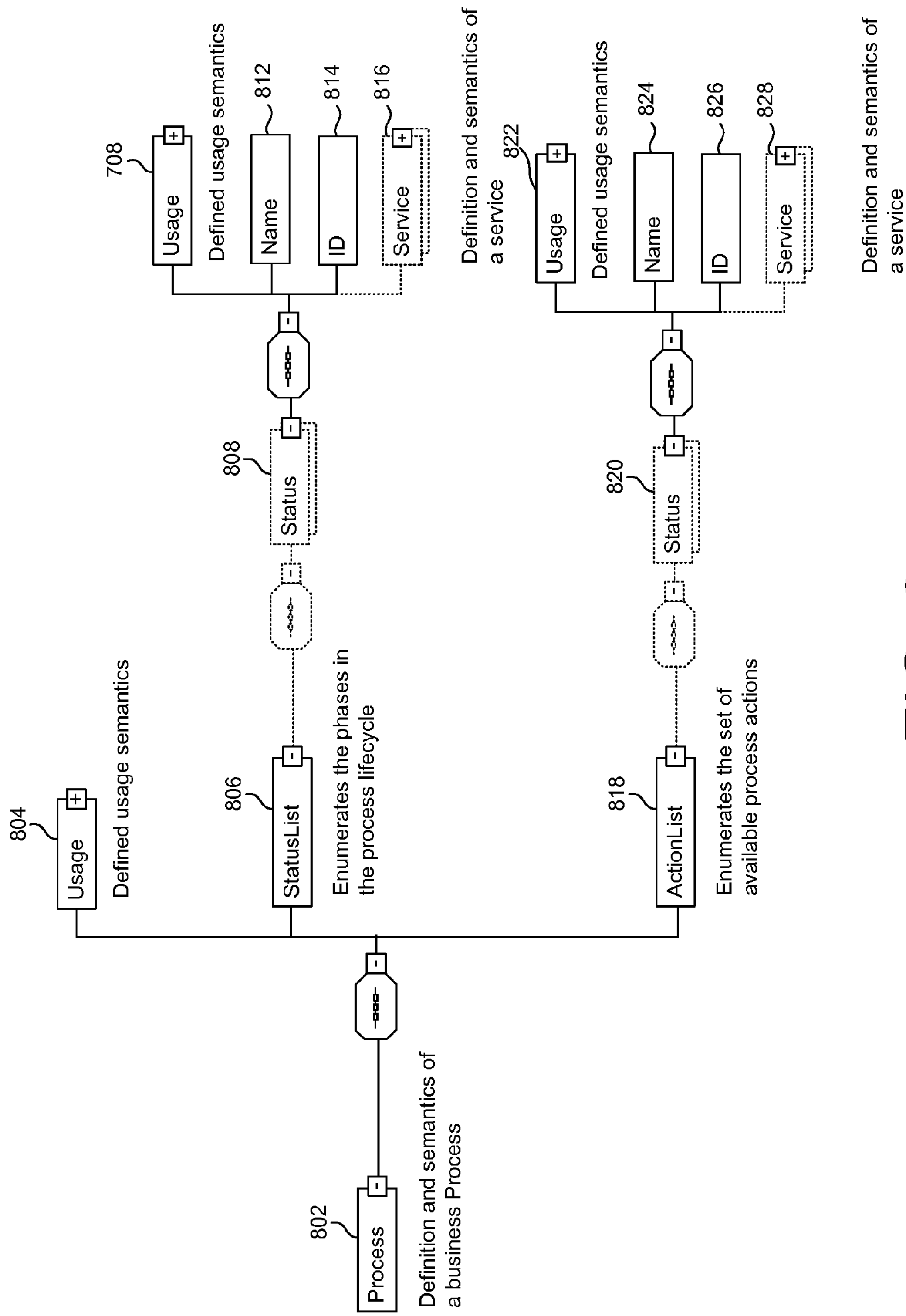

802
Process
Definition and semantics of a business Process
804
Usage
Defined usage semantics
806
StatusList
Enumerates the phases in the process lifecycle
808
Status
708
Usage
Defined usage semantics
812
Name
814
ID
816
Service
Definition and semantics of a service
818
ActionList
Enumerates the set of available process actions
820
Status
822
Usage
Defined usage semantics
824
Name
826
ID
828
Service
Definition and semantics of a service

FIG. 8

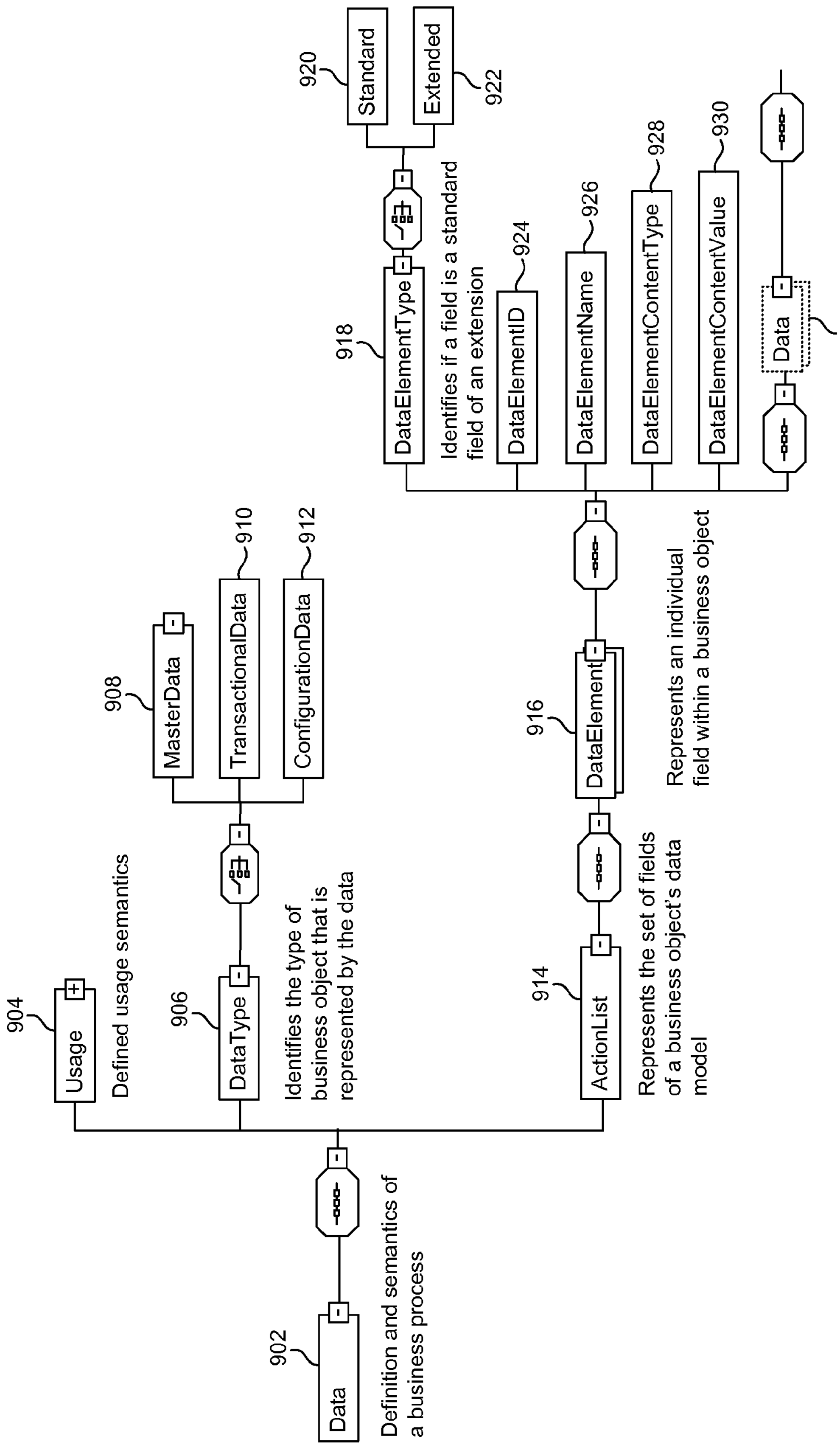

902
Data
Definition and semantics of a business process
904
Usage
Defined usage semantics
906
DataType
Identifies the type of business object that is represented by the data
908
MasterData
910
TransactionalData
912
ConfigurationData
914
ActionList
Represents the set of fields of a business object's data model
916
DataElement
Represents an individual field within a business object
918
DataElementType
Identifies if a field is a standard field of an extension
920
Standard
922
Extended
924
DataElementID
926
DataElementName
928
DataElementContentType
930
DataElementContentValue
932
Data

FIG. 9

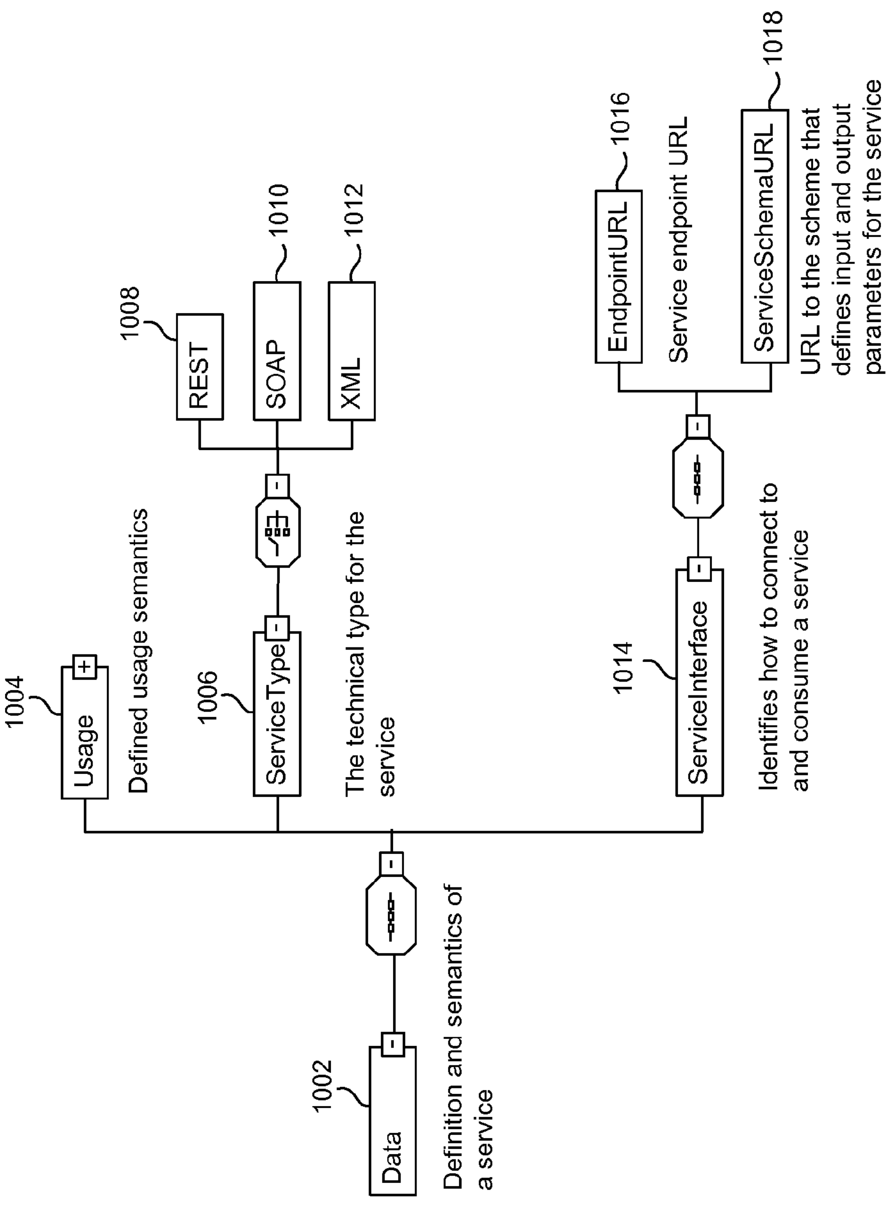
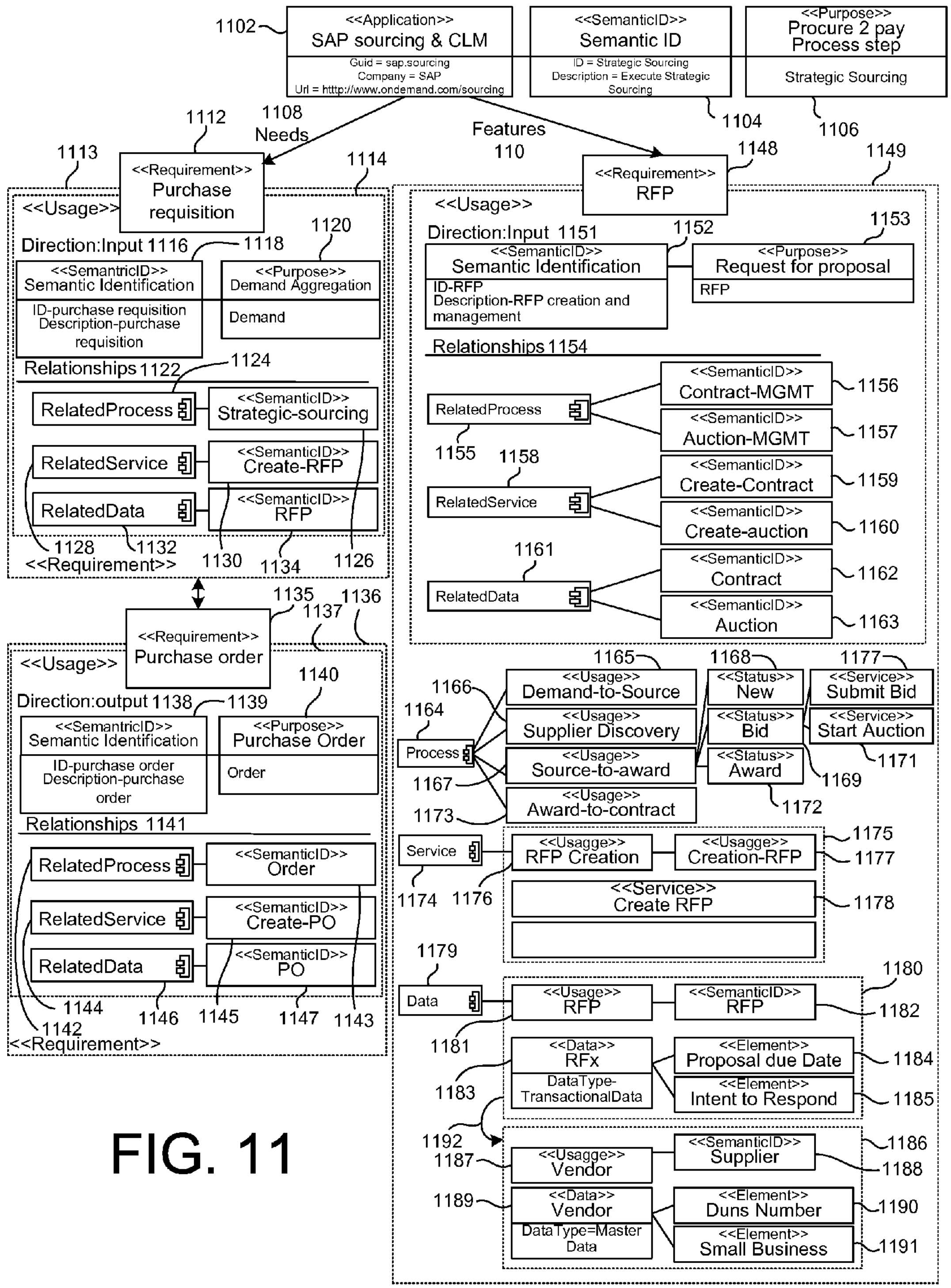

1002
Data
Definition and semantics of a service
1004
Usage
Defined usage semantics
1006
ServiceType
The technical type for the service
1008
REST
1010
SOAP
1012
XML
1014
ServiceInterface
Identifies how to connect to and consume a service
1016
EndpointURL
Service endpoint URL
1018
ServiceSchemaURL
URL to the scheme that defines input and output parameters for the service

FIG. 10



1102
<<Application>>
SAP sourcing & CLM
Guid = sap.sourcing
Company = SAP
Url = http://www.ondemand.com/sourcing
<<SemanticID>>
Semantic ID
ID = Strategic Sourcing
Description = Execute Strategic Sourcing
<<Purpose>>
Procure 2 pay
Process step
Strategic Sourcing
1104
1106
1112
1108
Needs
Features
110
1113
<<Requirement>>
Purchase requisition
1114
<<Usage>>
Direction:Input 1116
1118
1120
<<SemantricID>>
Semantic Identification
ID-purchase requisition
Description-purchase requisition
<<Purpose>>
Demand Aggregation
Demand
Relationships 1122
1124
RelatedProcess
<<SemanticID>>
Strategic-sourcing
RelatedService
<<SemanticID>>
Create-RFP
RelatedData
<<SemanticID>>
RFP
1128
1132
1130
1134
1126
<<Requirement>>
1135
1137
1136
<<Requirement>>
Purchase order
<<Usage>>
1140
Direction:output 1138
1139
<<SemantricID>>
Semantic Identification
ID-purchase order
Description-purchase order
<<Purpose>>
Purchase Order
Order
Relationships 1141
RelatedProcess
<<SemanticID>>
Order
RelatedService
<<SemanticID>>
Create-PO
RelatedData
<<SemanticID>>
PO
1144
1146
1145
1147
1143
1142
<<Requirement>>
1148
1149
<<Requirement>>
RFP
<<Usage>>
Direction:Input 1151
1152
1153
<<SemanticID>>
Semantic Identification
ID-RFP
Description-RFP creation and management
<<Purpose>>
Request for proposal
RFP
Relationships 1154
RelatedProcess
<<SemanticID>>
Contract-MGMT
1156
<<SemanticID>>
Auction-MGMT
1157
1155
1158
RelatedService
<<SemanticID>>
Create-Contract
1159
<<SemanticID>>
Create-auction
1160
1161
RelatedData
<<SemanticID>>
Contract
1162
<<SemanticID>>
Auction
1163
1165
1168
1177
1166
1164
Process
<<Usage>>
Demand-to-Source
<<Usage>>
Supplier Discovery
<<Usage>>
Source-to-award
<<Usage>>
Award-to-contract
<<Status>>
New
<<Status>>
Bid
<<Status>>
Award
<<Service>>
Submit Bid
<<Service>>
Start Auction
1171
1169
1167
1172
1173
Service
<<Usagge>>
RFP Creation
<<Usagge>>
Creation-RFP
1175
1177
<<Service>>
Create RFP
1178
1174
1176
1179
1180
Data
<<Usage>>
RFP
<<SemanticID>>
RFP
1182
1181
<<Data>>
RFx
DataType-TransactionalData
<<Element>>
Proposal due Date
1184
<<Element>>
Intent to Respond
1185
1183
1192
1187
<<Usagge>>
Vendor
<<SemanticID>>
Supplier
1186
1188
1189
<<Data>>
Vendor
DataType=Master Data
<<Element>>
Duns Number
1190
<<Element>>
Small Business
1191

FIG. 11

APPLICATION DISCOVERY AND INTEGRATION USING SEMANTIC METAMODELS

TECHNICAL FIELD

This description relates to integration of software applications.

BACKGROUND

Software applications, such as business applications, are often composed of multiple applications and related services, all working together. In some situations, application users may adopt a standard set of such applications and related services from a single supplier, in an attempt to ensure that the various components will work well together. However, in many scenarios, the best solutions to meet specific user needs are often made up of heterogeneous technologies in a hybrid landscape, combining best-in-class applications. Moreover, even in cases in which all components are obtained from a single supplier, there is no guarantee that the components will fit perfectly together. Consequently, integration of multiple software applications is often required, and typically represents a time-consuming, manually intensive, error prone, expensive, and generally inefficient process for obtaining the desired result.

SUMMARY

According to one general aspect, a system may include recorded on a non-transitory computer readable storage medium and executable by at least one processor. The system may include a metamodel selector configured to cause the at least one processor to determine a semantic metamodel for at least two software applications, the semantic metamodel including a description of semantics, processes, and data that are applicable to the at least two software applications. The system may include a metadata manager configured to cause the at least one processor to determine application metadata describing an application of the at least two applications. The system may include a transformation engine configured to cause the at least one processor to transform the application metadata into an application-specific metamodel instance of the semantic metamodel. The system may include an integration engine configured to cause the at least one processor to integrate the at least two software applications, based on the application-specific metamodel instance.

According to another general aspect, a computer-implemented method for causing at least one processor to execute instructions recorded on a computer-readable storage medium may include determining a semantic metamodel for at least two software applications, the semantic metamodel including a description of semantics, processes, and data that are applicable to the at least two software applications. The method may include determining application metadata describing an application of the at least two applications, transforming the application metadata into an application-specific metamodel instance of the semantic metamodel, and integrating the at least two software applications, based on the application-specific metamodel instance.

A computer program product may be tangibly embodied on a non-transitory computer-readable medium and may comprise instructions that, when executed, are configured to cause at least one processor to determine a semantic metamodel for at least two software applications, the semantic metamodel including a description of semantics, processes,

and data that are applicable to the at least two software applications. The instructions, when executed, may be further configured to determine application metadata describing an application of the at least two applications, transform the application metadata into an application-specific metamodel instance of the semantic metamodel, and integrate the at least two software applications, based on the application-specific metamodel instance.

The details of one or more implementations are set forth in the accompanying drawings and the description below. Other features will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a system for application discovery and integration using a semantic metamodel.

FIG. **2**A is a block diagram of a discovery process of the system of FIG. **1**.

FIG. **2**B is a block diagram of an integration process of the system of FIG. **1**.

FIG. **3** is a flowchart illustrating example operations of the system of FIG. **1**.

FIG. **4** is a diagram of an example semantic metamodel used in the system of FIG. **1**.

FIG. **5** is a more detailed example of the metamodel of FIG. **4**.

FIG. **6** is a more detailed example of the metamodel of FIG. **5**.

FIG. **7** is a more detailed example of usage semantics included in the metamodels of FIGS. **5** and **6**.

FIG. **8** is a more detailed example of a process list used in the metamodels of FIGS. **5** and **6**.

FIG. **9** is a more detailed example of a data list used in the metamodels of FIGS. **5** and **6**.

FIG. **10** is a more detailed example of a service list used in the example metamodels of FIGS. **5** and **6**.

FIG. **11** is a diagram of an example of an application-specific metamodel instance created using the metamodels of FIGS. **4-10** in the system of FIG. **1**.

DETAILED DESCRIPTION

FIG. **1** is a block diagram of a system **100** for application discovery and integration using semantic metamodels. In the example of FIG. **1**, one or more semantic metamodels **102** may be utilized by an application **104** to create an application-specific metamodel instance **106** therefrom. Thereafter, the application **104** may be integrated for use with a second application **108**, which itself may be associated with a corresponding application-specific metamodel instance **110**. In other words, by creating the application-specific metamodel instances **106**, **108** from the same, common underlying semantic metamodel **102**, the applications **104**, **108** may be easily integrated with one another, with little or no human involvement in the integration process, and in a manner that is generally more convenient, fast, cost effective, and efficient than existing integration techniques.

Thus, in the system **100**, one or more of the semantic metamodels **102** provide the application **104** with an ability to describe itself in a generic, common, high level language, where the resulting description is represented in FIG. **1** as the application-specific metamodel instance **106**. In other words, rather than focusing on specific details of an individual integration between two specified applications, and explicitly mapping semantics and data from one such application to the other, the semantic metamodel **102** enables the application

104 to generate its self-describing application-specific metamodel instance **106**, independently of any specific integration with any other software application. For example, as described in more detail below, it may occur that the application **108** may not even exist at a time that the application-specific metamodel instance **106** is created.

Nonetheless, once the application **108** is created, discovered, or otherwise identified or determined for integration with the application **104**, the semantic metamodels **102** (i.e., an appropriate semantic metamodel selected therefrom, as described below) provide for a generic, high level language for describing systems, data structures, and functionalities of each of the applications **104**, **108**, without affecting the underlying, actual low level implementations of these things in each application **104**, **108**, which may themselves therefore continue to function in system-specific, e.g., proprietary, ways.

In the example of FIG. **1**, the application **104**, and the application **108**, should be understood to conceptually represent virtually any software application. As such, either or both of the applications **104**, **108** should be understood to execute, e.g., locally, or in a secure environment behind a firewall, over a public network, or in any other suitable execution environment. In many of the examples that follow, the applications **104**, **108** are described as business applications, such as may be operated by a company, enterprise, or other business entity. However, again, it may be appreciated that such examples are non-limiting, and that the applications **104**, **108** also may represent many other types of software applications, such as, e.g., educational applications, government applications, charitable or other non-profit applications, or applications designed for personal use by a user.

Whatever a nature of type of the application **104**, FIG. **1** illustrates that a metadata manager **112** may be utilized to manage associated application metadata **114** which describes aspects, features, and functions of the application **104**. For example, the metadata **114** may describe a type and location of associated data, e.g., master data or configuration data, used by the application **104**. The metadata **114** also may describe various processes executed by the application **104**, e.g., processes for manipulating the above-referenced data and/or external data. In some cases, the metadata **114** may relate such processes to relevant use cases and descriptions thereof. For example, in the case of business applications, the metadata **114** may describe the application **104** in the context of various, relevant business processes and associated use cases.

In some cases, the metadata **114** may simply be provided in conjunction with the application, e.g., by a creator or publisher thereof, in which case the metadata manager **112** may be responsible simply for storing/accessing the metadata **114**. In other scenarios, the metadata manager **112** may be responsible for generating the metadata **114** automatically, e.g., based on an analysis of underlying application code of the application **104**. In still other examples, the metadata manager **112** may be configured to interact with a user of the application **104** to create the metadata **114**, even long after an original creation or publication of the application **104**.

As referenced above, it may occur that one or more semantic metamodels **102** are available for use with or by the application **104**. Accordingly, the application **104** is illustrated as including a metamodel selector **116**, which may be configured to select a particular semantic metamodel **118** from the one or more semantic metamodels **102** for creation of the application-specific metamodel instance **106**. Consequently, as described in more detail below, it may be appreciated that the application **108** should be understood to utilize some or all of the same semantic metamodel **118** in creating its associated, application-specific metamodel instance **110**.

Thus, in some examples, it may occur that, of the available semantic metamodels **102**, only one (i.e., the semantic metamodel **118**) is available or compatible for use with the application **104**. In other scenarios, it may occur that two or more of the semantic metamodels **102** could be used with the application **104**, but that the application **104** may choose from among the available subset of the semantic metamodels **102**, based on a desired nature and type of integration (e.g., based on a type of integration and associated semantic metamodel relevant to a type or class of application, or to the application **108** itself, if known at the time).

In practice, the metamodel selector **116** may operate by selecting or otherwise identifying one or more features or use cases contained within the metadata **114**, for comparison thereof against the semantic metamodels **102**. For example, such features may be pre-determined by the user of the application **104**, or may be dynamically selected by the metamodel selector **116**, based, e.g., on other aspects of the application **104**. Then, by comparing the thus-identified features of the application **104** from the metadata **114** to corresponding aspects of the semantic metamodels **102**, the metamodel selector **116** may identify the semantic metamodel **118** to be used in obtaining the application-specific metamodel instance **106**.

In the example of FIG. **1**, the semantic metamodels **102** are illustrated as being stored within a metamodel and model repository **115**. As described in detail below, the repository **115** provides a central, available, searchable location, which thus facilitates, e.g., operations of the metamodel selector **116** in selecting the semantic metamodel **118**. For example, in scenarios in which the system **100** is implemented in the context of a specific business or other enterprise, the repository **115** may be implemented within an associated on-premises IT environment. In other example implementations, however, as described in detail below, the repository **115** may be implemented in Cloud-based scenarios, in which the repository **115** is publicly available to all users of the application **104**.

In specific examples, the semantic metamodels **102**, including the semantic metamodel **118**, may be implemented as XML (extensible markup language) schemas. In general, as is known, such a schema describes allowable structures and contents of XML documents that are compatible therewith. Accordingly, a transformation engine **120** may be configured to utilize the semantic metamodel **118** together with the metadata **114**, to thereby provide the application-specific metamodel instance **106** as an XML document. As such, and in example implementations, the application-specific metamodel instance **106**, as well as the application-specific metamodel instance **110**, may be created, stored, and utilized using well-known techniques for searching for and manipulating XML documents. Nonetheless, it may appreciated that various other types of current or future schemas may be utilized to implement the semantic metamodels **102**.

In the example of FIG. **1**, the transformation engine **120** executes several different types of mappings in order to instantiate the semantic metamodel **118** using the metadata **114**, to thereby obtain the application-specific metamodel instance **106**. For example, the transformation engine **120** is illustrated as including a semantic mapper **122**, which may be operable to transform individual or combinations of terms and/or concepts within the metadata **114** into corresponding terms/concepts, using language consistent with the semantic metamodel **118**.

Detailed examples of such semantic mappings are provided in detail below, but, for the sake of illustration, it may occur that the application **104** is a business application related to obtaining a request for proposal (RFP), which uses the term "winning bid" obtained from a "vendor." At the same time, the semantic metamodel **118** may include a portion that relates to such RFPs, in which the semantic mapper **122** determines that a "supplier" is equivalent to a "vendor," and a "winning bid" contains final price information for a "line item" of an "outline agreement" defined in the semantic metamodel **118**. As may be appreciated with respect to the simplified example, the application **108** may utilize a term such as "seller" or "provider," yet the application-specific metamodel instance **110** associated therewith may similarly refer to such entities as "supplier," thereby providing the above-referenced common framework for referring to a given concept during a subsequent integration of the applications **104**, **108**.

Somewhat similarly, a process mapper **124** may map processes described in the metadata **114** to processes specified within the semantic metamodel **118**. In this regard, it may be appreciated that a single process of the metadata **114** may correspond to two or more processes of the semantic metamodel **118**, or, conversely, multiple processes of the metadata **114** may refer to a single process of the semantic metamodel **118**. In still other example scenarios, a given number of a plurality of processes of the metadata **114** may correspond to a same or different number of processes specified in the context of the semantic metamodel **118**. For example, it may occur that the metadata **114** describes a series of process steps, but that the semantic metamodel **118** only needs to specify a first and last step of the series of process steps in order to facilitate desired integrations of the application **104** with other applications, such as the application **108**. For example, in a pricing process, the metadata **114** may specify various rounds of negotiations (e.g., auctions) for lowering an initially offered price. Meanwhile, the semantic metamodel **118** may only require the fact that a price was requested and ultimately obtained for purposes of specifying the application-specific metamodel instance **106**.

Finally with respect to the transformation engine **120** of the example of FIG. **1**, the data mapper **126** may be configured to relate data types and specific data instances of the metadata **114** to the semantic metamodel **118**. For example, as referenced above, the data mapper **126** may seek to relate master data or configuration data of the application **104** to corresponding types of data within the semantic metamodel **118**.

The data mapper **126** may also be responsible for mapping individual data fields of data of the application **104** to corresponding data fields within the application-specific metamodel instance **106**. In this regard, it may be appreciated that, although examples of mapping data from one field to another are, by themselves, well known, the data mapper **126** of FIG. **1** provides for specific functionalities which enable these and other types of data mapping in the context of the semantic metamodel **118**, to thereby facilitate a desired integration of the application **104** in a manner that is partially or completely automated, and therefore generally more efficient and cost effective than existing techniques which require varying extents of manual identification of data fields to be mapped.

As referenced above, the repository **115** may serve as a central point of discovery, identification, and selection of one or more of the semantic metamodels **102** by the metamodel selector **116**. Similarly, an application matcher **128** may be utilized to discover, select, and utilize the application **108**, and/or other applications, for integration with the application **104**. In other words, the repository **115** may be used to register a plurality of applications, such as the application **108**, providing various features and functions which may be desirable to use in conjunction with operations of the application **104**. In practice, all such applications may be stored or referenced in conjunction with corresponding application-specific metamodel instances, so that, upon discovery/identification and selection thereof, any such application may be immediately available for integration with the application **104**, utilizing the various techniques described above, and in conjunction with operations of an integration engine **130**, described in more detail below.

For example, in a highly simplified example, it may occur that a user of the application **104** has specific knowledge of the individual application **108**, and may desire integration of the application **104** therewith. In such scenarios, the user of the application **104** may utilize the application matcher **128** simply to identify the application **108** within a repository **115**, perhaps simply by identifying the application **108** using an appropriate unique identifier or name. Thereafter, integration of the applications **104**, **108** may proceed as described herein.

In other example implementations, however, the user of the application **104** may not have such specific knowledge. Rather, the user may simply have an idea of a desired (type of) functionality to be implemented by, or in conjunction with, operations of the application **104**. In such cases, the application matcher **128** may be utilized to perform a search of applications stored in association with the repository **115**, in order to match available applications and their associated functionalities with the desired functionalities to be included in an integration with the application **104**.

For example, the application matcher **128** may be configured to search the applications of the repository **115** based on their corresponding names or other descriptions or metadata associated therewith, in order to ascertain a likelihood of desired functionality being provided thereby. Further, the application matcher **128** may restrict such searches to those applications which are associated with application-specific metamodel instances derived from the same semantic metamodel **118** utilized by the application **104** to generate the application-specific metamodel instance **106**, in order to ensure compatibility between applications identified by the application matcher **128** and the application **104**.

In more specific example implementations, the application-specific metamodel instance **106** may be provided with what is referred to herein as a bill of needs, which is designed to specify one or more functionalities that may be associated with the application **104**, i.e., that may be provided one of the applications **108** for access thereto by integration of the application with the application **104**.

As referenced above, and described in more detail below, the application-specific metamodel instance **106** may include various requirements of the application **104**, as translated from the metadata **114** by the transformation engine **120**, which specify functionalities and points of integration. Therefore, similarly, and as also explained in detail below, the bill of needs may be expressed using the same or substantially the same techniques as used in expressing such application features. In other words, the application features specify what the application **104** does, while the bill of needs specifies what the application **104** would like to have done by another application, which would presumably express its abilities in this regard in the context of its own application features included within its own application-specific metamodel instance.

Thus, the application matcher **128** may proceed by matching some or all of a bill of needs of the application-specific metamodel instance **106** with matching application features of the application-specific metamodel instance **110**, and thereafter executing integration of the applications **104**, **108** using the relevant portions of the application features and bill of needs of the application-specific metamodel instance **106** on the one hand, and the application features of the application-specific metamodel instance **110** on the other hand.

By way of more specific examples, with reference to FIG. **2**A, a discovery process that may be executed by the application matcher **128** is illustrated, in which the application **104** is illustrated as a requisition application which accesses the metamodel and model repository **115** to discover the application **108** as a sourcing application for integration therewith. In the example, as referenced above, the application-specific metamodel instance **106** may include both application features **202** and bill of needs **204** associated with the requisition application **104**.

As described, the format and structure of the application features **202** and **204** may be identical or substantially identical, although the application features **202** specify capabilities and characteristics of the requisition application **104**, while the bill of needs **204** express one or more desired capabilities and characteristics which are sought in the context of a sourcing application, such as the sourcing application **108**. Meanwhile, the sourcing application **108** is illustrated as being associated with application features **206** of its own application-specific metamodel instance **110**. As may be appreciated, the application features **206** may include a format and structure that matches both the application features **202** and bill of needs **204** of the application-specific metamodel instance **106**, all of which are in accordance with the common semantic metamodel **118**.

By way of specific, non-limiting example, it may occur that the requisition application **104** corresponds to a Cloud-based human resources system, which may wish to make use of a Cloud survey tool to support employee performance reviews. Meanwhile, the sourcing application **108** may represent one of perhaps a plurality of such survey tools. In operation, an owner or other provider of the survey tool **108** may wish to make such a survey tool publicly available for use in conjunction with the repository **115**. In this regard, such a provider may publish or otherwise register the survey tool **108** in the repository **115**. For example, rather than storing the survey tool **108** itself in conjunction with the repository **115**, the provider may simply register a reference to the survey tool **108**, in conjunction with registration of the corresponding application-specific metamodel instance **110**, which itself may be made available for search and discovery within the repository **115**.

It may be further appreciated that the applications **104**, **108** may be developed completely independently of one another, and at different times. For example, the requisition application **104**, e.g., the human resources application referenced above, may be developed before the sourcing application, e.g., the survey tool **108**, even exists. Nonetheless, a developer or other provider of the human resources application **104** may recognize a potential need for such a survey tool, and may provide specifics of such a need within the bill of needs **204**.

Thus, at some later time, an administrator or other user of the human resources application **104** may in fact wish to utilize the functionality of such a survey tool, and may be provided with an administrative dashboard or other user interface in the context of the human resources application **104**, in which each general feature specified by the bill of needs **204**, including the referenced survey tool, may be paired with a list of available services of the repository **115** and may be used to support the specified feature.

Then, the administrator may simply need to select a subscribe button or other appropriate interface element in order to initiate integration of the applications **104**, **108** and thereby activate the desired functionality. Thereafter, for example, new buttons (or other UI artifacts) may be provided or enabled within the human resources application **104**, in order to provide for launching an operation of the survey tool **108**. In this way, the administrator of the human resources application **104** may identify and select the survey tool **108** as providing desired functionality, even if the survey tool **108** did not exist, and/or was developed wholly independently of, the human resources application **104**. Moreover, it may be appreciated that the administrator may similarly update the desired survey functionality, using a different survey tool than the survey tool **108**, if desired and if/when such a preferred survey tool becomes available within the repository **115**.

FIG. **2**B illustrates an integration of the requisition application **104** and the sourcing application **108**, as conceptually illustrated by arrow **208**. For example, the integration engine **130** of FIG. **1** may be utilized to leverage the application-specific metamodel instances **106**, **110**, in order to automatically integrate the applications **104**, **108** at a suitable or desired manner.

For example, the integration engine **130** may implement a mediated integration, in which the integration engine **130** or other suitable component serves as a central point of interaction between inputs and outputs of the applications **104**, **108**. In other example implementations, the integration **208** may be direct, so that the outputs of each application **104**, **108** are suitably provided as direct inputs to the other of the applications **104**, **108** as inputs thereof. In these and other examples, it may be appreciated that the various inputs/outputs of the applications **104**, **108** are commonly specified and described through the use of the corresponding application-specific metamodel instances **106**, **110**.

With reference back to FIG. **1**, application **104** is illustrated as being executed using at least one computing device **132**, which itself includes at least one processor **132**A and computer readable storage medium **132**B. That is, for example, instructions for execution of the application **104** may be stored using the computer readable storage medium **132**B, and may be executed by the at least one processor **132**A in order to obtain various features and functions described herein.

For example, the at least one processor **132**A may represent multiple processors executed in parallel. Meanwhile, the computer readable storage medium **132**B may be utilized to store data of the application **104**, such as master data or configuration data, or the metadata **114**, as well as the actual instructions for execution of the application **104**. Of course, the at least once computing device **132** may include, or be associated with, various peripheral components (e.g., human interface devices for displays), various power components, and various network or other communication interfaces, none of which are specifically illustrated in the example of FIG. **1**, for the sake of simplicity and clarity.

Similarly, the at least one computing device **132** is represented generically in FIG. **1** for the sake of simplicity, but may be understood to represent any appropriate computing device, such as, e.g., a desktop computer, a computer of a computing cluster, or any appropriate mobile computing device (e.g., a laptop, notebook, netbook, tablet, or Smartphone). Further, in as much as the at least one computing device **132** may represent two or more computing devices in communication with one another, it may be appreciated that some or all of the functionalities described with respect to the application **104** may be implemented on a first such computing device, while remaining operations may be executed on the one or more computing devices and communications therewith.

For example, in particular, it may be appreciated that any of the various components **112-130** illustrated as executing in conjunction with the application **104** may be, in fact, executed separately from the application **104**, e.g., using a separate computing device and/or a separate application or other hardware/software platform. In particular, for example, it may occur that the metamodel selector **116**, the transformation engine **120**, the application matcher **128** and/or the integration engine **130** may individually or collectively be executed outside of, and in communication with, the application **104**. For example, these components may be operated as a middleware between the application **104** and the repository **115**. Similarly, it may occur that these components are provided in conjunction with the repository **115** itself, using an appropriate Cloud-based hardware/software platform. Similarly, the metadata manager **112** may also be implemented separately from the application **104**, such as in scenarios in which the application **104** is not initially provided with appropriate metadata **114**.

Thus, from the above description, it should be apparent that, in various example scenarios, the application **104** may simply be an otherwise-conventional application, which may be registered with the repository **115** by an owner or other provider thereof. Thereafter, a provider of the repository **115** may utilize the various components **112-130** to generate the application-specific metamodel instance **106** for association with the application **104** within the repository **115**, to thereby make the application **104** publicly available for integration with other applications utilizing the same semantic metamodel (e.g., **118**) of the semantic metamodels **102**. Such examples may be suitable for scenarios in which providers of the application **104** are unwilling or unable to generate the corresponding application-specific metamodel instance **106**.

In other example scenarios, however, it may occur that the semantic metamodels **102**, including the semantic metamodel **118**, represent a known standard for commonly expressing features and needs of applications. In such scenarios, providers of such applications as the application **104** may desire to obtain the benefits of such a standard representation, and may adopt use of a corresponding, appropriate semantic metamodel in order to generate the application-specific metamodel instance **106** for registration in conjunction with the application **104** within the repository **115**. Of course, similar comments and scenarios may apply to the application **108** and its corresponding application-specific metamodel instance **110**, and to all such applications and associated metamodel instances registered in the context of the repository **115**.

Thus, an aggregate and over time, the repository **115** may come to represent a large store of available applications which may be easily, e.g., automatically, integrated with one another in desired fashions, to thereby provide developers and other application users with desired functionalities in a cost-effective and efficient manner. Moreover, such advantages may be obtained even though the various application-specific metamodel instances are developed independently, in conjunction with their underlying applications, and without requiring knowledge of, or even existence of, the other applications which may be integrated therewith at some future point in time. Thus, the developers and other users of the various applications may each be provided with a large number and variety of potentially desirable applications and associated features, as well as with the ability to utilize such applications and associated features in a convenient manner.

FIG. **3** is a flowchart **300** illustrating example operations of the system **100** of FIG. **1**. In the example of FIG. **3**, operations **302-308** are illustrated as separate, sequential operations. However, it may be appreciated that, in various implementations, any two or more of the operations **302-308** may be implemented in a partially or completely overlapping or parallel manner, or in a nested, iterative, or looped fashion. Further, additional or alternative operations may be included, and, in various implementations, one or more of the operations **302-308** may be omitted.

In the example of FIG. **3**, a semantic metamodel may be determined for at least two software applications, the semantic metamodel including a description of semantics, processes, and data that are applicable to the at least two software applications (**302**). For example, the metamodel selector **116** of FIG. **1** may select the semantic metamodel **118** from the available semantic metamodels **102** of the metamodel and model repository **115**. In some examples, only a single semantic metamodel may be applicable or compatible with a given software application, such as the application **104**, so that metamodel selection per se need not be performed in every scenario. Further, as referenced above, it is not necessary to know of an existence, much less a particular identity, of both of the at least two software applications in order to utilize the selected semantic model with respect to a software application. Rather, the operation **302** merely requires that the referenced semantic metamodel provides the referenced description in a manner that is applicable to the at least two software applications, and, as described in detail herein, provides each of the at least two software applications with an ability to describe itself for current or future integration with the other application.

Application metadata describing an application of the at least two applications may be determined (**304**). For example, the metadata manager **112** of FIG. **1** may determine the metadata **114** of the application **104**. As described, the metadata **114** may be currently available and stored in association with the application **104**, and/or may be partially or completely generated for the application **104** by the metadata manager **112**. As described, the metadata **114** may generally describe various features, aspects, or requirements of the application **104**, in a manner that is generally application or assistant-specific, so that such applications may be provided with corresponding metadata in a manner that is suitable for (e.g., proprietary to) the given application and/or underlying platform.

The application metadata may be transformed into an application-specific metamodel instance of the semantic metamodel (**306**). For example, the transformation engine **120** may transform the metadata **114**, using the semantic metamodel **118**, to obtain the application-specific metamodel instance **106**. In this way, the application in question, e.g., the application **104**, may describe itself for current or future integrations.

Thus, the at least two software applications may be integrated, based on the application-specific metamodel instance (**308**). For example, the integration engine **130** may be configured to utilize integration points (e.g., input/output interfaces) identified by the application-specific metamodel instance **106** with respect to the application **104**, in order to integrate the application **104** with the application **108**.

Thus, FIG. **3** may be understood to represent a high-level operational flow of example, basic operations of the system **100** of FIG. **1**. As referenced above with respect to FIG. **3**, various additional or alternative operations may be included, many of which may be understood or appreciated from the above description of FIGS. **1**, **2**A, **2**B.

For example, although not specifically recited in FIG. **3**, the second of the at least two software applications may generally also be associated with a corresponding application-specific metamodel instance (e.g., the application-specific metamodel instance **110** associated with the application **108**), so that the integration engine **130** may utilize both such instances to implement the integration of the applications **104**, **108**.

Similarly, FIG. **3** does not explicitly mention the use of the bill of needs referenced above, e.g., with respect to FIG. **2**A, and associated matchings thereof between the bill of needs **204** of the requisition application **104** and corresponding application features **206** of the sourcing application **108**. Nonetheless, again, it may be appreciated that any and all such additional or alternative operations may be included in an appropriate or desired manner in the context of the overall operational flow of the flowchart **300** of FIG. **3**. Many such additional or alternative features and associated operations are described below with respect to the specific examples of FIGS. **4-11**.

FIG. **4** is a diagram **400** of a metamodel to be utilized in conjunction with a business application and its associated usage semantics. For example, such a metamodel may represent, e.g., the semantic metamodel **118** of FIG. **1**. In the example of FIG. **4**, an application **402** is described by corresponding attributes **404**. In the example, as shown, the attributes **404** may include a globally unique identifier (GUID) **406**, which will uniquely identify an underlying application used to instantiate the metamodel of FIG. **4**. In other words, a result of instantiating the metamodel of FIG. **4** would be, e.g., the application-specific metamodel instance **106**, so that the GUID **406** would assist in relating the resulting metamodel instance to the specific application in question.

Further within the attributes **404**, a company **408** that is responsible for the application in question may be identified. Similarly, a uniform resource locator (URL) **410** may be included, which identifies the responsible company **408** through the use of a URL link, e.g., to the company website or relevant portion thereof.

Further in FIG. **4**, a semantic ID **412** is included, which generally represents information relating to a description, purpose, and context of the application **402**. More detailed examples of the semantic ID **412** are provided below, e.g., with respect to FIG. **5**.

Also in FIG. **4**, features **414** refer to a set of requirements filled by the application **402** and exposed for external use. In other words, the features **414** corresponds generally to the application features **202** of FIG. **2**A. Similarly, needs **416** refer to a set of requirements that the application **402** desires or needs to be filled by some other application or service, in order to provide a corresponding functionality. Thus, the needs **416** responds generally to the bill of needs **204** described above with respect to FIG. **2**A.

FIG. **5** is an expanded version of FIG. **4**, in which each of the semantic ID **412**, features **414**, and needs **416** are expanded to provide a more detailed view of each. Specifically, as shown, the semantic ID **412** is associated with a semantic ID structure **502**, in which a unique identifier **504** provides identification for a semantic usage of the semantic ID **412**. Meanwhile, a description **506** provides a human readable description of the usage semantics, which may be included in corresponding, generated documentation. Further, a purpose **508** is included in the semantic ID structure and includes a machine-readable declaration of the semantic usage.

As shown, the purpose **508** may include a standard purpose **510**, referring to a set of predefined purposes for all compatible business applications. As further shown, with respect to the standard purposes **510**, such purposes may include integration **512**, associated process step **514**, associated analytics **516**, and/or associated monitoring **518**. The purpose **508** also may include an extended purpose **520**, which may refer, for example, to extensions added by a customer or other consumer or purchaser of a relevant application. Thus, the extended purpose **520** identifies application-specific purpose or semantic usages associated with such customizations.

With regard to the features **414**, a plurality of associated requirements **521** may be enumerated, where each requirement **522** may include, for example, usage semantics **524**, one or more process lists **526**, data list **528**, and service list **530**. As may be appreciated from the above description of FIG. **1**, such lists and related information may correspond with the semantic mapper **122**, the process mapper **124**, and the data mapper **126** of the transformation engine **120** of FIG. **1**.

As shown, the usage **524** may relate generally to define usage semantics for the application **402** and its associated requirements **521**. The process list **526** may refer generally to a set of processes for the requirement **522**. The data list **528** provides a relevant set of data for the defined requirement **522**. Finally, similarly, the service list **530** defines the subset of services for the defined requirement.

As also described above, the needs **416** correspond generally to the type of bill of needs described above, e.g., the bill of needs **204** of FIG. **2**A. Consequently, in contrast to the features **414** and the requirements **521** which specify set of requirements filled by the application **402** and exposed for external use, the needs **416** and associated requirements **531** provide a set of requirements that the application **402** needs or desires to be filled by some other application or service, e.g., the application **108**.

As may be observed, the corresponding requirement structure **532** may correspond substantially or completely identical to the requirement structure **522** associated with the requirement **521** of the features **414**. In this way, for example, it may be a straightforward extension for a provider or user of the metamodel of FIG. **4** to add the needs **416** to the metamodel, due to familiarity with the features **414** and associated data requirements **521/522**. Moreover, due to such identity between the requirements **521/522** and the needs **416**, including requirements **531** and requirement structure **532**, it may be straightforward to determine integration points at which the application **402** provides integration points for integration with a second application, which itself, as described with respect to FIG. **2**A may utilize requirements **206** which are identical in form and structure to the requirement structures **522**, **532**.

FIG. **6** is a further expanded view of the metamodel of FIG. **5**, in which additional detail regarding the usage semantics **524/534** are provided. As illustrated, a given instance of such usage semantics may be associated with its own semantic ID **602** that identifies a semantic usage thereof, as well as a direction **604** that identifies a direction of data flow, and relationships **606** that represent a set of valid relationships and associations between various semantic entities. Further, as may be expected from the similarity between the requirement **522** and the requirement **532**, the usage semantic **534** of the requirement **532** also may be associated with a semantic ID **608**, direction **610**, and relationship **612**, which may be similar or the same in structure and form with respect to the semantic ID **602**, the direction **604**, and the relationship **606**. Moreover, the semantic ID **602/608**, although not specifically illustrated in FIG. **6**, may have a structure and format that is identical or substantially identical to the semantic ID **502**, which consequently is not reproduced here in detail.

FIGS. **7**, **8**, **9**, **10** provide further detail with respect to the usage semantic **524**, the process list **526**, the data list **528**, and the service list **530**, respectively, of the requirement **522**. Of course, in this regard, it may be appreciated that the example of FIGS. **7-10** will also be applicable to the identical structures **534**, **536**, **538**, **540** of the requirement **532**.

Thus, in the example of FIG. **7**, further detail regarding usage semantics **701** are provided. As already described, the usage semantics may include the semantic ID **602**, which is shown in expanded form as being identical to the semantic ID **502** of FIG. **5**, as referenced above. Meanwhile, the direction **604** is expanded to illustrate an example direction **702**, and which input **704** and output **706** directions are identified for corresponding data flows.

Further in FIG. **7**, a relationship structure **707** illustrates an example form and format for relationship **708** of the set of valid relationships and associations **606** described above. That is, as shown, the relationship **708** may identify related processes **710** in a corresponding list, which identify the referenced related processes **712** themselves, along with semantic ID **714** that associates a current related process reference to the actual defined process. Again, the semantic ID **714** may correspond in form and format to the semantic ID **502**.

Similarly, a list of related data **716** may reference corresponding related data **718**, which is associated by virtue of the semantic ID **720**. Finally in FIG. **7**, and similarly, a list of related services **722** may be associated with a corresponding related service **724** by semantic ID **726**.

With reference back to, e.g., the requirement **522** of FIGS. **5**, **6**, the process list **526** may be associated with a process **802** of FIG. **8**, which, as illustrated, provides a definition and associated semantics of a particular business process. Specifically, as shown, usage semantics **804** may be provided, along with a status list that enumerates various phases in the process life cycle of the process **802**.

Then, corresponding status information **808** may be provided, utilizing associated usage semantics **810**, in conjunction with a process name **812** and ID **814**, as well as a service definition **816** providing a definition and semantics of related services. It may be noted that the usage semantics **804** and **810** (as well as **822**, described below) may correspond to the usage data structures described above with respect to FIG. **7**, in the appropriate context illustrated in FIG. **8**. Similarly, the service definition and semantics **816** may correspond to related data structures described below with respect to FIG. **10** (similar comments apply to the service **828**, described below).

Further in FIG. **8**, an action list **818** associated with the process **802** enumerate the set of available process actions, shown in FIG. **8** of actions **820**. As referenced, each action **820** may be associated with corresponding defined usage semantics **822**, name **824**, ID **826** and associated definition/semantic of related services.

FIG. **9** provides further detail with regard to the data list **528/538** of FIGS. **5/6**. Specifically, as shown, data **902** used or produced may be associated with corresponding defined usage semantics **904**. A data type **906** may be used to identify the type of business object represented by particular data. For example, as shown, the data type **906** may include master data **908**, transactional data **910**, and/or configuration data **912**.

Further, data elements **914** may be used to represent a set of fields of a business object's data model. Corresponding data elements **916** may thus represent an individual field within a business object. Then, the data element **916**, as shown, may be associated with a data element type **918** that identifies whether a field is a standard field **920** or an extension **922**. The data element **916** may also be associated with a data element ID **924**, a data element name **926**, a data element content type **928**, and a data element content value **930**. Finally with respect to FIG. **9**, the data element may be further associated with a data collection **932** of child business objects.

FIG. **10**, as referenced above, provides further detail with respect to the service list **530/540** of FIGS. **5/6**. As shown, a service **1002** may be associated with corresponding definition and semantics. Specifically, as shown, usage semantics **1004** may be included. Further, a technical service type **1006** for the service **1002** may be specified, such as, e.g., REST **1008**, SOAP **1110** and/or XML **1012**.

Further with respect to FIG. **10**, a service interface **1014** may be included which identifies a manner in which a related service **1002** may be connected and consumed. Consequently, the service interface **1014** may specify an end point URI (uniform resource identifier) **1016** associated with the service. Further, a service schema URI **1018** may be provided as a URI pointing a schema that defines input and output parameters for the service **1002** in question.

FIG. **11** is a diagram of an application-specific metamodel instance created in conjunction with the application metamodel described above with respect to FIGS. **4-10**. Specifically, as shown, an application **1102** may provide strategic sourcing technologies and techniques. As shown, the application **1102** may be associated with corresponding attributes corresponding to the attributes **404** of FIG. **4**. Specifically, as shown, such attributes may include a GUID, a company identifier, and a corresponding URL. Further, a semantic ID **1104** corresponding to the semantic ID **412** of FIG. **4** may be included which itself may include a purpose **1106** corresponding, for example, to the purpose **508** of FIG. **5**, which provides a machine-readable declaration of the semantic usage of the application in question.

Further, the example of FIG. **11** provides specific instances of needs **1108**, corresponding to the needs **416** of FIG. **4**, as well as features **1010** corresponding to the features **414** of FIG. **4**. Then, in the specific example, the needs **1108** may include a first requirement **1112** related to a purchase requisition. As shown, the requirement structure **1113** includes usage semantics **1114**, again corresponding to the related structures of FIGS. **5**, **6**. Specifically, as shown, a direction **1116** specifies an input direction, and a semantic ID **1118** provides an ID for a purchase requisition and associated description. Again, the semantic ID **1118** is linked to a purpose **1120**, e.g., a purpose of aggregating demand.

Then, relationships **1122** may specify related processes **1124**, such as may be associated with a semantic ID **1126** for strategic sourcing. Similarly, a related service **1128** may be associated with a semantic ID for creating a request for proposal (RFP). Further, related data **1132** may be associated with a semantic ID for **1134** for the RFP itself.

Similar, and supply to a second need/requirement **1135** for a purchase order, specifically, as shown, the requirement **1136** includes usage semantics **1137**, including a direction **1138** specifying an output direction. A semantic ID **1139** again specifies an ID (i.e., purchase order) and associated description, and is associated with a purpose **1140** of providing a purchase order.

Relationships **1141** specify a related process **1142** having a semantic ID **1143** for an order to be issued. A related service **1144** is associated with a semantic ID **1145** describing creation of a purchase order (PO). Further, related data **1146** is associated with a semantic ID for the PO **1147** itself.

Similar comments apply to the example RFP requirement **1148**, and associated data structure **1149**. Specifically, as shown, a usage semantics **1150** specifies a direction **1151** as an input direction. A semantic ID **1152** provides a corresponding RFP identifier and description, along with a purpose **1153** specifying the purpose of request for a proposal.

Relationships **1154** include a related process **1155** having a semantic **1156** for contract management, and a semantic ID **1157** for auction management. A related service **1158** is associated with a semantic ID **1159** for creation of a contract, as well as a semantic ID **1160** for creation of an auction. Related data **1161** is associated with a semantic ID **1162** for the resulting contract itself while, similarly, a semantic **1163** provides the created/managed auction.

Further, a process **1164** corresponding to the description of FIG. **8** includes usage semantics **1165** describing a demand-to-source, a usage net **1166** related to supplier discovery, usage semantics **1167** relating source-to-award, and usage semantics **1173** relating award-to-contract. As further shown, the usage semantics **1167** may include a status **1168** (new), a status **1169** (bid), and status **1172** (award). As also shown, the status **1169** may include a specified service **1170** for submitting a bid, as well as a service **1171** for starting a related auction.

A service **1174** corresponding conceptually to the service of FIG. **10**, includes a structure **1175** that specifies usage semantics **1176** related to RFP creation, which has a semantic ID **1177** associated therewith. Then, a service **1178** is specified as having a service type SOAP, along with a relevant URI and service schema URI. Then, data **1179**, corresponding to FIG. **9**, provides data structure **1180** which specifies usage semantics **1181** related to an RFP, along with a corresponding semantic ID **1182**. A data type **1183** specifies an RFx with element **1184** related to a proposal due date, and element **1185** related to an intent to respond. Then, structure **1186** includes usage semantics **1187** for a vendor, having a semantic ID **1188** shown as "supplier." A data type **1189** for the vendor will be shown as master data, where, in the example, one element is a DUNS number **1190**, and a second element **1191** identifies the vendor as a small business. Finally with respect to FIG. **9**, a relationship **1192** is also illustrated between the data structures **1180**, **1186**.

Thus, with respect to the above description of FIGS. **1-10**, the application-specific metamodel instance of FIG. **11** may be understood to illustrate such an instance for an underlying sourcing application. In the example, the various features **1110** illustrate that the application in question has the capabilities to provide an RFP. Further, the needs **1108** specify that, in order to provide the RFP, the application may desire or require a second application to generate a purchase requisition **1112** and/or a purchase order **1135**.

As described in detail, the application in the example of FIG. **11** may thus represent, for example, the requisition application **104** of FIG. **2**A, in which the needs **1108** correspond to the bill of needs **204** described with respect thereto, and the features **1110** correspond to the application features **202**. Then, some second application and corresponding application-specific metamodel instance, not specifically illustrated with respect to FIG. **11**, and corresponding to the sourcing application **108** of FIG. **2**A, may be discovered within the repository **115**. Thereupon, the application of FIG. **11** may easily be integrated with one or more such applications in order to fulfill the needs **1108** in an automatic, cost effective, and efficient manner.

For the sake of further illustration example, a developed XML schema for representing one of the semantic metamodels **102** of FIG. **1** is provided below. Of course, it may be appreciated that the provided XML schema is intended merely for the sake of further illustration example with respect to a particular implementation of such a semantic metamodel, in conjunction with the examples provided above with respect to FIGS. **4-11**. Thus, in this regard, the provided XML schema should not be understood to be limiting of the types of current and future techniques that may be utilized to represent the semantic metamodels **102**.

Code Portion 1

Implementations of the various techniques described herein may be implemented in digital electronic circuitry, or in computer hardware, firmware, software, or in combinations of them. Implementations may implemented as a computer program product, i.e., a computer program tangibly embodied in an information carrier, e.g., in a machine-readable storage device or in a propagated signal, for execution by, or to control the operation of, data processing apparatus, e.g., a programmable processor, a computer, or multiple computers. A computer program, such as the computer program(s) described above, can be written in any form of programming language, including compiled or interpreted languages, and can be deployed in any form, including as a stand-alone program or as a module, component, subroutine, or other unit suitable for use in a computing environment. A computer program can be deployed to be executed on one computer or on multiple computers at one site or distributed across multiple sites and interconnected by a communication network.

Method steps may be performed by one or more programmable processors executing a computer program to perform functions by operating on input data and generating output. Method steps also may be performed by, and an apparatus may be implemented as, special purpose logic circuitry, e.g., an FPGA (field programmable gate array) or an ASIC (application-specific integrated circuit).

Processors suitable for the execution of a computer program include, by way of example, both general and special purpose microprocessors, and any one or more processors of any kind of digital computer. Generally, a processor will receive instructions and data from a read-only memory or a random access memory or both. Elements of a computer may include at least one processor for executing instructions and one or more memory devices for storing instructions and data. Generally, a computer also may include, or be operatively coupled to receive data from or transfer data to, or both, one or more mass storage devices for storing data, e.g., magnetic, magneto-optical disks, or optical disks. Information carriers suitable for embodying computer program instructions and data include all forms of non-volatile memory, including by way of example semiconductor memory devices, e.g., EPROM, EEPROM, and flash memory devices; magnetic disks, e.g., internal hard disks or removable disks; magneto-optical disks; and CD-ROM and DVD-ROM disks. The processor and the memory may be supplemented by, or incorporated in special purpose logic circuitry.

To provide for interaction with a user, implementations may be implemented on a computer having a display device, e.g., a cathode ray tube (CRT) or liquid crystal display (LCD) monitor, for displaying information to the user and a keyboard and a pointing device, e.g., a mouse or a trackball, by which the user can provide input to the computer. Other kinds of devices can be used to provide for interaction with a user as well; for example, feedback provided to the user can be any form of sensory feedback, e.g., visual feedback, auditory feedback, or tactile feedback; and input from the user can be received in any form, including acoustic, speech, or tactile input.

Implementations may be implemented in a computing system that includes a back-end component, e.g., as a data server, or that includes a middleware component, e.g., an application server, or that includes a front-end component, e.g., a client computer having a graphical user interface or a Web browser through which a user can interact with an implementation, or any combination of such back-end, middleware, or front-end components. Components may be interconnected by any form or medium of digital data communication, e.g., a communication network. Examples of communication networks include a local area network (LAN) and a wide area network (WAN), e.g., the Internet.

While certain features of the described implementations have been illustrated as described herein, many modifications, substitutions, changes and equivalents will now occur to those skilled in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the scope of the embodiments.

What is claimed is:

1. A system including instructions recorded on a non-transitory computer readable storage medium and executable by at least one processor, the system comprising:

a metamodel selector configured to cause the at least one processor to determine a semantic metamodel applicable to at least two software applications, the semantic metamodel including a description of semantics, processes, and data that are applicable to the at least two software applications;

a metadata manager configured to cause the at least one processor to obtain first application metadata describing functionality provided by a first software application of the at least two software applications;

a transformation engine configured to cause the at least one processor to transform the first application metadata into a first application-specific metamodel instance of the semantic metamodel, the transformation including translating the first application metadata into requirements that specify application functionality for the first software application, and mapping a portion of the requirements in the first software application to requirements in a second software application of the at least two software applications, the portion selected based on discovering that the first software application is requesting functionality associated with the second software application; and

an integration engine configured to cause the at least one processor to integrate the at least two software applications, including the portion, based on the first application-specific metamodel instance and the requested functionality, and based on a second application-specific metamodel instance of the semantic metamodel obtained from second application metadata of the second software application,

wherein the transformation engine is configured to cause the at least one processor to transform the first application metadata into the first application-specific metamodel instance of the semantic metamodel independently of the second application-specific metamodel instance.

2. The system of claim **1**, wherein the metamodel selector is further configured to search a metamodel repository storing a plurality of semantic metamodels to select the semantic metamodel therefrom.

3. The system of claim **2**, wherein the metamodel selector includes a feature selector configured to select portions of the first application metadata for use in selecting the semantic metamodel from the plurality of semantic metamodels.

4. The system of claim **1**, wherein the metadata manager is configured to provide the first application metadata based on an analysis of the first software application.

5. The system of claim **1**, wherein the transformation engine includes:

a semantic mapper configured to perform a mapping of semantics of the first software application metadata using the semantics description of the semantic metamodel and for inclusion within the first application-specific metamodel;

a process mapper configured to perform a mapping of processes described in the first application metadata using the processes description of the semantic metamodel and for inclusion within the first application-specific metamodel; and

a data mapper configured to perform a mapping of data described in the first application metadata using the data description of the semantic metamodel and for inclusion within the first application-specific metamodel.

6. The system of claim **1**, wherein the semantic metamodel defines features applicable to the at least two software applications, and the first application-specific metamodel instance includes instantiations of a subset of the defined features that are provided by the first software application.

7. The system of claim **1**, wherein the semantic metamodel defines needs applicable to the at least two software applications, and the first application-specific metamodel instance includes instantiations of a subset of the defined needs that are requested by the application for fulfillment thereof by the second software application.

8. The system of claim **7**, wherein a repository is configured to store a plurality of application-specific metamodel instances corresponding to a plurality of applications, including the at least two applications, and further comprising an application matcher configured to match needs of the first software application with features of at least one of the stored application-specific metamodel instances, for fulfillment therewith.

9. The system of claim **8**, wherein the application matcher is further configured to perform a search of the stored application-specific metamodel instances in the repository that are instantiated from the semantic metamodel, based on the needs of the first software application.

10. A computer-implemented method for causing at least one processor to execute instructions recorded on a computer-readable storage medium, the method comprising:

determining a semantic metamodel applicable to at least two software applications, the semantic metamodel including a description of semantics, processes, and data that are applicable to the at least two software applications;

obtaining application metadata describing functionality provided by a first software application of the at least two software applications;

transforming the first application metadata into a first application-specific metamodel instance of the semantic metamodel, the transformation including translating the first application metadata into requirements that specify application functionality for the first software application, and mapping a portion of the requirements in the first software application to requirements in a second software application of the at least two software applications, the portion selected based on discovering that the first software application is requesting functionality associated with the second software application; and

integrating the at least two software applications, including the portion, based on the first application-specific metamodel instance and the requested functionality, and based on a second application-specific metamodel instance of the semantic metamodel obtained from second application metadata of the second software application,

wherein the transformation engine is configured to cause the at least one processor to transform the first application metadata into the first application-specific metamodel instance of the semantic metamodel independently of the second application-specific metamodel instance.

11. The method of claim **10**, wherein the transforming further includes:

performing a mapping of semantics of the first software application metadata using the semantics description of the semantic metamodel and for inclusion within the first application-specific metamodel;

performing a mapping of processes described in the first application metadata using the processes description of the semantic metamodel and for inclusion within the first application-specific metamodel; and

performing a mapping of data described in the first application metadata using the data description of the semantic metamodel and for inclusion within the first application-specific metamodel.

12. The method of claim **10**, wherein the semantic metamodel defines features applicable to the at least two software applications, and the first application-specific metamodel instance includes instantiations of a subset of the defined features that are provided by the first software application.

13. The method of claim **10**, wherein the semantic metamodel defines needs applicable to the at least two software applications, and the first application-specific metamodel instance includes instantiations of a subset of the defined needs that are requested by the application for fulfillment thereof by the second software application.

14. A computer program product, the computer program product being tangibly embodied on a non-transitory computer-readable medium and comprising instructions that, when executed, are configured to cause at least one processor to:

determining a semantic metamodel applicable to at least two software applications, the semantic metamodel including a description of semantics, processes, and data that are applicable to the at least two software applications;

obtaining application metadata describing functionality provided by a first software application of the at least two software applications;

transforming the first application metadata into a first application-specific metamodel instance of the semantic metamodel, the transformation including translating the first application metadata into requirements that specify application functionality for the first software application, and mapping a portion of the requirements in the first software application to requirements in a second software application of the at least two software applications, the portion selected based on discovering that the first software application is requesting functionality associated with the second software application; and

integrating the at least two software applications, including the portion, based on the first application-specific metamodel instance and the requested functionality, and based on a second application-specific metamodel instance of the semantic metamodel obtained from second application metadata of the second software application,

wherein the transformation engine is configured to cause the at least one processor to transform the first application metadata into the first application-specific metamodel instance of the semantic metamodel independently of the second application-specific metamodel instance.

15. The computer program product of claim **14**, wherein the instructions, when executed, are further configured to:

perform a mapping of semantics of the first application metadata using the semantics description of the semantic metamodel and for inclusion within the first application-specific metamodel;

perform a mapping of processes described in the first application metadata using the processes description of the semantic metamodel and for inclusion within the first application-specific metamodel; and

perform a mapping of data described in the first application metadata using the data description of the semantic metamodel and for inclusion within the first application-specific metamodel.

16. The computer program product of claim **14**, wherein the semantic metamodel defines features applicable to the at least two software applications, and the first application-specific metamodel instance includes instantiations of a subset of the defined features that are provided by the first software application.

17. The computer program product of claim **14**, wherein a repository is configured to store a plurality of application-specific metamodel instances corresponding to a plurality of applications, including the at least two applications, and further comprising an application matcher configured to match needs of the first software application with features of at least one of the stored application-specific metamodel instances, for fulfillment therewith.

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